Claims

What is claimed is:

1. An optical filter comprising:

a first optical element including a first reflective element for receiving light and reflecting a first wavelength band of the light centered at a first reflection wavelength, the first reflective element characterized by a first filter function; and

a second optical element, optically connected to the first optical element to receive the reflected first wavelength band of the light, including a second reflective element for reflecting a second wavelength band of the light centered at a second reflection wavelength, the second reflective element characterized by a second filter function being different than the first filter function;

whereby the first reflection wavelength and the second reflection wavelength are aligned to reflect a portion of the aligned wavelength bands to ~~an output port.~~

2. The optical filter of claim 1, wherein one of the first and second optical elements is tunable to approximately align the first and second reflection wavelengths.

3. The optical filter of claim 1, wherein both of the first and second optical elements is tunable to approximately align the first and second reflection wavelengths.

4. The optical filter of claim 1, further comprising:

an optical directing device optically connected to the first and second optical elements; the optical directing device directing the light to the first reflective element, directing the first wavelength band reflected from the first reflective element to the second reflective element, and directing the second wavelength band reflected from the second reflective element to the output port of the optical directing device.

Sub C7

5. The optical filter of claim 4, wherein the optical directing device comprises at least one circulator.

6. The optical filter of claim 5 wherein the circulator receives the light at a first port of the circulator, directs the light to the first reflective element through a second port of the circulator, receives the first wavelength band at the second port, directs the first wavelength band to the second reflective element through a third port of the circulator, receives the second wavelength band at the third port, and directs the second wavelength band to a fourth port of the circulator.

7. The optical filter of claim 4 wherein said optical directing device comprises an optical coupler.

8. The optical filter of claim 1, wherein the first reflection wavelength and the second reflection wavelength are substantially aligned to reflect a portion of the aligned wavelength bands to an output port.

Sub A2

9. The optical filter of claim 8, wherein one of the first and second filter functions comprises one of a Gaussian, rectangular and ramped profile.

10. The optical filter of claim 1, wherein one of the first and second reflective elements is fully apodized and the other of the first and second reflective elements is partially apodized.

Sub C5

Sub C5 end

11. The optical filter of claim 1, wherein the first reflection wavelength is offset a predetermined spacing from the second reflection wavelength.

Sub A3

12. The optical filter of claim 1, wherein at least one of the first and second tunable optical elements have an outer cladding and an inner core disposed therein, wherein the first reflective element comprises a first grating disposed in a longitudinal direction of the inner core of the first optical element, and the second reflective element comprises a second grating disposed in a longitudinal direction of the inner core of the second tunable optical element.

Sub C1

13. The optical filter of claim 12, wherein the at least one of the first and second optical elements comprises:

an optical fiber, having a reflective element written therein; and

a tube, having the optical fiber and the reflective element encased therein along a longitudinal axis of the tube, the tube being fused to at least a portion of the fiber.

Sub A4

14. The optical filter of claim 12, wherein the at least one of the first and second optical elements has an outer transverse dimension of at least 0.3 ~~mm.~~

Sub C2

15. The optical filter of claim 12, wherein the at least one of the first and second optical elements is an optical fiber.

Sub A5

16. The optical filter of claim 3 further includes a compressing device for compressing simultaneously and axially the first and second tunable optical elements, wherein each of the first and second reflective elements are disposed along an axial direction of each respective first and second tunable ~~element.~~

17. The optical filter of claim 3 further comprising:

a first compressing device for compressing axially the first tunable optical element to tune the first reflective element, wherein the first reflective element is written in the longitudinal direction in the first tunable optical element; and

a second compressing device for compressing axially the second tunable optical element to tune the second reflective element, wherein the second reflective element is written in the longitudinal direction in the second tunable optical element.

18. The optical filter of claim 1 further includes a straining device for tensioning axially the first optical element to tune the first reflective element, wherein the first reflective element is disposed along an axial direction of the first optical element.

19. The optical filter of claim 1 further includes a heating element for varying the temperature of the first optical element to tune the first reflective element to reflect the selected first wavelength band.

20. The optical filter of claim 2 further includes:

a first compressing device for axially compressing at least the first tunable optical element to tune the first reflective element, responsive to a displacement signal, wherein the first reflective element is disposed axially along the first tunable element; and

a displacement sensor, responsive to the compression of the first tunable optical element, for providing the displacement signal indicative of the change in the displacement of the first tunable optical element.

21. The optical filter of claim 20, wherein the displacement sensor includes a capacitance sensor coupled to the first tunable optical element for measuring the change in the capacitance that depends on the change in the displacement of the first tunable optical element.

22. A tunable optical filter comprising:

a tunable optical element for receiving light, the optical element comprising:

a first reflective element for receiving light and reflecting a first wavelength band of the light centered at a first reflection wavelength, the first reflective element characterized by a first filter function; and

a second reflective element, optically connected to the first reflective element to receive the reflected first wavelength band of the light, for reflecting a second wavelength band of the light centered at a second reflection wavelength, the second reflective element characterized by a second filter function;

whereby the first reflection wavelength and the second reflection wavelength are approximately aligned to reflect a portion of the aligned ~~wavelength bands to an output port.~~

23. The optical filter in claim 22, wherein the tunable optical element comprises an optical waveguide including a cladding having a first and second inner core therein for propagating light, wherein the first reflective element is disposed along an axial direction in the first inner core, and the second grating is disposed along an axial direction in the second inner core.

24. The optical filter of claim 23, wherein tunable optical element has an outer transverse dimension of at least 0.3 mm.

25. The optical filter of claim 23, further comprising:

an optical directing device optically connected to the first and second tunable optical elements; the optical directing device directing the light to the first reflective element, directing the first wavelength band reflected from the first reflective element to the second reflective element, and directing the second wavelength band reflected from the second reflective element to the output port of the optical directing device.

Sub C15

26. The optical filter of claim 25, wherein the optical directing device comprises at least one circulator.

27. The optical filter in claim 23 further includes at least a compressing device for axially compressing the tunable optical element to tune the first and second reflective elements.

28. The optical filter of claim 22, wherein the first and second reflection wavelengths are substantially aligned.

Sub C17

29. The optical filter of claim 22, wherein the first and second reflective elements have different filter functions.

30. The optical filter of claim 22, wherein the first and second reflection wavelengths are offset by a predetermined spacing.

31. The optical filter of claim 22 further includes:

a compressing device for axially compressing the tunable optical element to tune the first and second gratings, responsive to a displacement signal, wherein the first and second gratings are disposed axially along the tunable optical element; and

a displacement sensor, responsive to the compression of the tunable optical element, for providing the displacement signal indicative of the change in the displacement of the tunable optical element.

32. A method for selectively filtering an optical wavelength band from an input light; the method comprising:

providing a first optical element including a first reflective element for receiving the input light and reflecting a first wavelength band of the light centered at a first reflection wavelength, the first reflective element characterized by a first filter function;

providing a second optical element, optically connected to the first optical element to receive the reflected first wavelength band of the light, including a second reflective element for reflecting a second wavelength band of light centered at a second reflection wavelength, the second reflective element characterized by a second filter function being different than the first filter function; and

tuning one of the first and second reflective elements to align approximately the first reflection wavelength and the second reflection wavelength to reflect a portion of the aligned wavelength bands to an output port.

and B9

Sub C21

33. The method of claim 32 wherein the tuning one of the first and second reflective elements includes compressing the one of the first and second optical elements.

Sub A9

34. The method of claim 32, wherein the tuning one of the first and second reflective elements comprises:

substantially aligning a first reflection wavelength and a second reflection wavelength.

Sub C27

35. The method of claim 32, wherein one of the first and second reflective elements is fully apodized and the other of the first and second reflective elements is partially apodized.

36. The method of claim 31, wherein the tuning one of the first and second reflective elements comprises:

offsetting a first reflection wavelength and a second reflection wavelength by a predetermined spacing.

37. A compression-tuned optical filter comprising:

a first optical element including a first reflective element for receiving light and reflecting a first wavelength band of the light centered at a first reflection wavelength, the first reflective element characterized by a first filter function; and

a second optical element, optically connected to the first optical element to receive the reflected first wavelength band of the light, including a second reflective element for reflecting a second wavelength band of the light centered at a second reflection wavelength, whereby the first reflection wavelength and the second reflection wavelength are aligned to reflect a portion of the aligned wavelength bands to an output port;

wherein at least one of the first and second optical element has outer dimensions along perpendicular axial and transverse directions, the outer dimension being at least 0.3 mm along said transverse direction, at least a portion of the respective first or second tunable element having a transverse cross-section which is contiguous and comprises a substantially homogeneous material; and the respective first or second reflective element being axially strain compressed so as to change respective first or second reflection wavelength without buckling the respective first or second tunable element in ~~the transverse direction.~~

add A11

add 32,1